MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

EME2146 - APPLIED THERMODYNAMICS

(ME)

26 OCTOBER 2017
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This exam paper consists of only three printed pages, including this cover page.

2. Answer all questions.

3. Write all your answers in the answer booklet provided.

4. A property table booklet is provided.

Question 1

a). Use the Maxwell relations to determine a relation for $(\partial s/\partial v)_T$ for a gas whose equation of state is $(P - a/v^2)(v - b) = RT$. [5 marks]

b). Use the Clapeyron equation to estimate the enthalpy of vaporization of refrigerant-134a at 40°C, and compare it to the tabulated value. [10 marks]

c). The maximum efficiency (the Carnot efficiency, $\eta = 1 - T_l/T_h$) of a steam plant obtainable depends on the absolute temperature of the fuel core (T_h) and that of the primary circulating coolant (T_l): the cooler the circulating coolant or the hotter the fuel core, the higher will be the efficiency of the power plant. Now, suppose you wish to increase the efficiency of a Carnot engine as much as possible; and you can do this stuff by increasing T_h a certain amount while keeping T_l constant, or by decreasing T_l the same amount while keeping T_h constant. Explain and show which you would do: increase T_h or lower T_l. [5 marks]

Question 2

a). A geothermal power plant uses geothermal liquid water at 160°C at a rate of 440 kg/s as the heat source, and produces 14 MW of net power in an environment at 25°C. An exergy of 18.5 MW entering the plant with the geothermal water is destructed within the plant. Determine the exergy of the geothermal water entering the plant, the second-law efficiency, and the exergy of the heat rejected from the plant. [10 marks]

b). Explain why thermodynamically some energy conversion devices are more efficient than others? Give some examples to show your answer. [5 marks]

c). An aluminum pan has a flat bottom whose diameter is 25 cm. Heat is transferred steadily to boiling water in the pan through its bottom at a rate of 800 W. If the temperatures of the inner and outer surfaces of the bottom of the pan are 104°C and 105°C, respectively, determine the rate of exergy (in W) destruction within the bottom of the pan during this process. Take the ambient temperature to be 30°C. [5 marks]

Question 3

a). A rigid tank that contains 1 kg of N_2 at 25°C and 300 kPa is connected to another rigid tank that contains 3 kg of O_2 at 25°C and 500 kPa. The valve connecting the two tanks is opened, and the two gases are allowed to mix. The final mixture temperature is still 25°C. Determine the volume of each tank and the final mixture pressure. [10 marks]

b). i). How does a natural-draft wet cooling tower work? [5 marks]

ii). What is a spray pond, and how does its performance compare to that of a wet cooling tower? [5 marks]

c). How does the presence of N_2 or moisture in air affect the outcome of a combustion process? [5 + 5 marks]

Question 4

a). A steam power plant operates on a simple ideal Rankine cycle between the pressure limits of 3 MPa and 50 kPa. The temperature of the steam at the turbine inlet is 300°C, and the mass flow rate of steam through the cycle is 35 kg/s. Show the cycle on a *T-s* diagram with respect to saturation lines, and determine the thermal efficiency of the cycle and the net power output of the power plant. [10 marks]

b). Explain why steam injection increases the power output and efficiency of gas turbines, and how to obtain the steam. [10 marks]

c). When selecting a refrigerant for a certain application, what qualities would you look for in the refrigerant? Answer by stating five desirable characteristics of a refrigerant. [10 marks]

End of Paper